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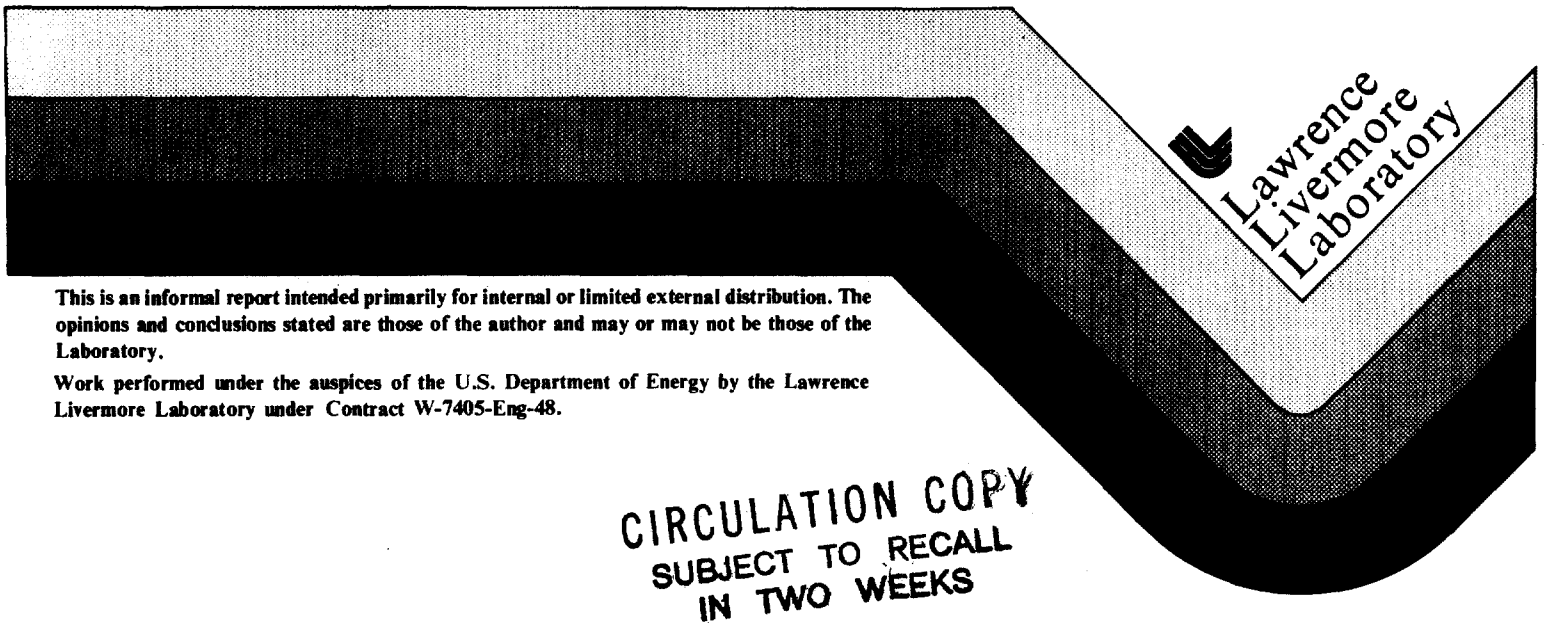

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PRELIMINARY COMPARISONS BETWEEN MEASUREMENTS AND MODEL CALCULATIONS FOR THE TMI VENTING OF ^{85}KR

Marvin H. Dickerson

Lawrence Livermore National Laboratory, University of California
Livermore, California 94550

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Introduction

ARAC was on-line calculating hourly concentration values during the TMI-2 venting of Kr^{85} gas from June 28 to July 11, 1980. During this time hourly isopleths of normalized instantaneous concentration were calculated and transmitted to EPA in Middletown, PA. These isopleths were used to help locate the EPA and Penn State moble air samplers and they were used for comparison to the EPA fixed 24 hr sampler measurements and the DOE helicopter measurements. This report summarizes preliminary comparisons for the EPA fixed samplers and the DOE helicopters. Both the helicopter and EPA measurement data were received by telephone conversations with the individuals responsible for analyzing the samples. Source-term data were received in written form from an EPA representative stationed in the control room. The reader should exercise caution in reading too much detail into these comparisons as they were done in a first estimate fashion. Later a more detailed and realistic comparison is planned when more measurements will be available and the actual source term is specified in model comparisons (in FY-1981 and subject to funding availability).

Results

All comparisons between the model calculations and EPA fixed 24 hr monitors were made assumming that the ADPIC instantaneous air concentration values were

valid for an hour. These χ/Q (s/m^3) values, interpolated between contour values, were multiplied by the source term (pCi/sec) which gives pCi/m^3. This process was used for each hour of the 24 hr period. These values were added and divided by 24 to give an hourly average surface concentration value (pCi/m^3) consistant with the measurements of hourly concentration during a 24 hr period. As long as the wind direction was relatively steady during each one hour period this procedure should yield a reasonable comparison. Under light and variable conditions (as occurred on several occasions) this process can underestimate the concentration by as much as an order of magnitude or more. It is also possible to overestimate concentrations, but to a lesser degree, if a change in wind direction that moves the plume away from the sampler is unaccounted for.

The helicopter measurements, since they were essentially instantaneous, were more straightforeward to compare with the model calculations. We presently have maximum values recorded at a given x, y, z location. More detail will be available from these measurements at a later date.

Table 1 lists a comparison between the model calculations and EPA measurements from June 28 to July 10 for the Middletown (MDT) (sector 1, 5 km from source point) and Bainbridge (BBR) (sector 7, 8 km from source point) samplers. These two samplers were the only ones (out of five) that were far enough away from the source point to be within the resolution of the model ($\Delta x = \Delta y =$ 750 m). Also, listed in Table 1 is the frequency by day of the sector into which the wind was transporting the Kr^{85}. Measurements for MDT and BBR for 6/29 - 6/30, 7/2 - 7/3 and 7/7 - 7/8 compare favorably with model calculations. Underestimates for MDT for 7/3 - 7/4 and 7/4 - 7/5 can be explained by winds that were light and variable during the time the direction was such that ^{85}Kr plume would pass near or over the Middletown sampler. As mentioned above, under these conditions, we expect to underestimate the concentration. Comparisons for BBR during these two

days show good to excellent agreement. For 6/30 - 7/1, 7/6 - 7/7, and 7/8 - 7/9 calculated and measurement values for BBR and MDT are opposite to what they should be. It is difficult to justify the 510 160 and 250 pCi/m^3 respectively measured at MDT when winds for these periods were transporting the ^{85}Kr into the east to south quadrants. It appears as though the sampler values were switched. Another discrepancy occurs for 7/1 - 7/2 when the model calculated 10,400 pCi/m^3 for MDT and the samplier measured background. The backgroud measurement is again hard to justify when the wind was transporting the ^{85}Kr into the north and north-northeast sector 12 hours during this time. Model overestimates for 6/28 - 6/29 and 7/5 - 7/6 cannot be explained at this time unless these discrepancies represent transport errors. A summary of these comparisons is shown in Table 2. Perhaps when other sampler values became available from EPA and Met-Ed these discrepancies can be resolved.

Tables 3 through 8 show comparisons between model calculations and helicopter measurements for the six flights during the initial period of the purge. Lower limit of detectability for the instrumentation was 20 pCi/m^3. Figures 1 through 6 show model calculations at stack height (60m) in the form of isopleths of instantaneous concentration normalized to a unit rate release. Since most flights, with the exception of the morning flight for June 30, occured for approximately 2 1/2 hours only model calculations for the mid-point of the flights are shown although the three calculations nearest to flight time were used for the estimates shown in Tables 3 through 8. In making these comparisons the innermost contour value and the maximum calculated value were used with the appropriate hourly source term to estimate instantaneous values shown in these tables. Comparison between the sectors where the maximum concentrations were reported by the helicopter and the concentration isopleths shown in the companion figure shows excellent agreement between the model calculations and the helicopter measurements. In general, a

comparison between the concentration values measured by the helicopter and those calculated by the model are within a factor of two to three, which again is excellent agreement.

Summary and Recommendations

As all surface sampler measurement data become available and when the helicopter measurements have been refined, a more detailed model versus measurement comparison will be justified. This first order analysis has shown an excellent consistency between helicopter measurments and model calculations. Comparisons to EPA surface measurements leave several unanswered questions which are:

- Apparent or potential errors in reporting location versus measured concentrtion values. On three days (6/30 - 7/1, 7/6 - 7/7, 7/8 - 7/9) measurements above background were reported at MDT and background was measured at BBR. Model calculations showed the reverse.
- On 7/1 - 7/2 a value of 10,400 pCi/m^3 was calculated for MDT and background was reported by the measurements.
- Model overestimates for 6/28 - 6/29 and 7/5 - 7/6 are possibly the result of transport errors in the calculations; however, the final conclusion will have to wait for a more detailed analysis.

This preliminary analysis has re-inforced our confidence in the value of airborne versus surface measurement systems. The airborne system is usually not restricted to monitoring specific locations and can therefore seek out the maximum concentration areas of the concentration pattern and in some cases these systems can provide profiles of concentration as a function of x, y, z and t. In the case of surface measurements it is impossible to determine the location of the measurement with respect to the overall concentration pattern unless a prohibitive number of

moniters are utilized. In many instances the measurement is made at the edge of the concentration pattern where a small error in wind direction produces a large discrepancy between the measurement and the model calculation. In future radiological accidents and problems similar to the TMI venting the value of airborne radiological measurement systems cannot be over emphasized.

Acknowledgments

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js/fw/1294z

TABLE 1. Summary of model estimates and measurements for Middletown (MDT) and Bainbridge (BBR) sampler locations and number of hours wind directions was into a given sector.

Time (EDT)	Sampler (pCi/m^3)		Sectors														
	MDT	BBR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
6/28-29	200* (bkg)+	— (bkg)											1				3	2
6/29-30	1970 (1500)	— (bkg)	3	4		2	2	1	1	4					2	1		1
6/30-7/1	— (510)	1900 (bkg)						1	1	19	3							
7/1-2	10400 (bkg)	— (bkg)	9	3					1	1	1							4
7/2-3	1920 (3000)	— (bkg)	2	9	1				1	2		3	1	2	1	1	1	
7/3-4	460 (2300)	270 (770)	5					6	5	1	1	2	1	1	1		1	
7/4-5	80 (1080)	175 (178)	5			1	1	1	1	3	3				1	3	1	4
7/5-6	2430 (240)	1169 (20)	4	1	3		1	1	3	9	2							
7/6-7	— (160)	2000 (bkg)					2	2	1	4	15							
7/7-8	1400 (330)	— (bkg)	2	1	1	3	3	1	2		1		1				3	6
7/8-9	— (250)	66 (bkg)				5	5	4	2	6	2							
7/9-10					1	1	3	1		1	1							
TOTAL HOURS			30	18	6	12	17	18	18	50	29	5	4	3	5	5	9	17
PERCENTAGE			12	7	2	5	7	8	8	20	12	2	2	1	2	2	3	7

*Estimated from model calculation.

+Measured.

TABLE 2. Summary of Model Calculation and EPA surface sampler measurements.

	MDT	BBR
6/28 - 6/29	Disagree	Agree
6/29 - 6/30	Agree	Agree
6/30 - 7/1	Switched	
7/1 - 7/2	Disagree	Agree
7/2 - 7/3	Agree	Agree
7/3 - 7/4	Light & Variable Winds	Agree
7/4 - 7/5	Light & Variable Winds	Agree
7/5 - 7/6	Disagree	Disagree
7/6 - 7/7	Switched	
7/7 - 7/8	Agree	Agree
7/8 - 7/9	Switched	

TABLE 3. Comparison between helicopter measurement and concentration estimates based on model calculations for June 29, 1980, 1500-1730 EDT.

HELICOPTER MEASUREMENTS*

0.5 mile from site

200'	137 pCi/liter	Sector 2
300'	50 pCi/liter	Sector 2
500'	50 pCi/liter	Sector 2
750'	17 (approx. lower limit of detectability)	Sector 2

4 miles down centerline 20 pCi/liter

MODEL CALCULATIONS

Time	Source (pCi/s)	Instantaneous Calculations (s/m^3)		Estimated Concentration (pCi/liter)	
		Innermost Contour	Maximum Value	Innermost Contour	Maximum Value
1500	3.3×10^{10}	3×10^{-6}	3.1×10^{-6}	100	100
1600	5.6×10^{10}	3×10^{-6}	3.1×10^{-6}	150	150
1700	5.5×10^{10}	3×10^{-6}	4×10^{-6}	75	75

*Exact times of all helicopter measurements listed in Tables 3 through 8 were not known at the time this report was written. These times will be available after the data have been analyzed in more detail.

TABLE 4. Same as Table 3 except model calculations are for June 30, 1980, 1100-1140 EDT.

HELICOPTER MEASUREMENTS

0.75 mile from site

200'	31 pCi/liter	Sector 7
300'	56 pCi/liter	Sector 7
400'	48 pCi/liter	Sector 7
500'	21 pCi/liter	Sector 7
750'	24 pCi/liter	Sector 7

MODEL CALCULATIONS

Time	Source (pCi/s)	Instantaneous Calculations (s/m^3)		Estimated Concentration (pCi/liter)	
		Innermost Contour	Maximum Value	Innermost Contour	Maximum Value
1100	4.2×10^{10}	1×10^{-6}	2.6×10^{-6}	42	110
1200	4.2×10^{10}	3×10^{-6}	3.5×10^{-6}	126	150

TABLE 5. Same as Table 3 except model calculations are for June 30, 1980, 1800-1945 EDT.

HELICOPTER MEASUREMENTS

0.9 miles from site

200'	19 pCi/liter	Sector 7
300'	6 pCi/liter	Sector 7
400'	52 pCi/liter	Sector 7
500'	51 pCi/liter	Sector 7
750'	28 pCi/liter	Sector 7

MODEL CALCULATIONS

Time	Source (pCi/s)	Instantaneous Calculations (s/m^3)		Estimated Concentration (pCi/liter)	
		Innermost Contour	Maximum Value	Innermost Contour	Maximum Value
1800	$5x10^{10}$	$3x10^{-6}$	$3.7x10^{-6}$	150	185
1900	$5x10^{10}$	$3x10^{-6}$	$3.4x10^{-6}$	150	170
2000	$6x10^{10}$	—	—	—	—

TABLE 6. Same as Table 3 except model calculations are for July 1, 1980, 1115-1245 EDT.

HELICOPTER MEASUREMENTS

0.5 miles from site

200'	23 pCi/liter	Sector 6
300'	88 pCi/liter	Sector 6
400'	91 pCi/liter	Sector 6
500'	98 pCi/liter	Sector 6
750'	126 pCi/liter	Sector 5

0.9 miles from site

400'	31 pCi/liter	Sector 7
750'	26 pCi/liter	Sector 6

1.2 miles from site

200'	20 pCi/liter	Sector 5
300'	29 pCi/liter	Sector 5
500'	34 pCi/liter	Sector 5

2.2 miles from site

1500-2000'	20 pCi/liter	Sectors 5 & 6

MODEL CALCULATIONS

Time	Source (pCi/s)	Instantaneous Calculations (s/m^3)		Estimated Concentration (pCi/liter)	
		Innermost Contour	Maximum Value	Innermost Contour	Maximum Value
1100	$1x10^{11}$	$3x10^{-6}$	$4x10^{-6}$	300	400
1200	$6x10^{10}$	$3x10^{-6}$	$4x10^{-6}$	180	240
1300	$3x10^{9}$	—	—	90	120

TABLE 7. Same as Table 3 except model calculations are for July 1, 1980, 1800-2000 EDT.

HELICOPTER MEASUREMENTS

0.25 miles from site

200'	496 pCi/liter	Sectors 2 & 3
300'	344 pCi/liter	Sectors 2 & 3
400'	218 pCi/liter	Sectors 2 & 3

1 mile from site

200'	133 pCi/liter	Sector 3
300'	121 pCi/liter	Sector 2
400'	99 pCi/liter	Sector 3
500'	94 pCi/liter	Sector 3

2 miles from site

200'	32 pCi/liter	Sector 3
300'	48 pCi/liter	Sector 3
400'	48 pCi/liter	Sectors 3 & 4
500'	46 pCi/liter	Sectors 2 & 3

MODEL CALCULATIONS

Time	Source (pCi/s)	Instantaneous Calculations (s/m^3)		Estimated Concentration (pCi/liter)	
		Innermost Contour	Maximum Value	Innermost Contour	Maximum Value
1800	9×10^{10}	1×10^{-6}	2.5×10^{-6}	90	225
1900	1×10^{11}	3×10^{-6}	3.8×10^{-6}	300	380
2000	9×10^{10}	3×10^{-6}	3.8×10^{-6}	270	340

TABLE 8. Same as Table 3 except model calculations are for July 2, 1980, 0640-0805 EDT.

HELICOPTER MEASUREMENTS

0.25 miles from site

200'	249 pCi/liter	Sectors 1 & 2
300'	171 pCi/liter	Sectors 1 & 2
400'	318 pCi/liter	Sectors 1 & 2
500'	172 pCi/liter	Sectors 1 & 2
750'	144 pCi/liter	Sectors 1 & 2
1000'	18 pCi/liter	Sectors 1 & 2

1 mile from site

200'	29 pCi/liter	Sectors 2 & 3
300'	48 pCi/liter	Sectors 2 & 3
400'	65 pCi/liter	Sectors 2 & 3
500'	77 pCi/liter	Sectors 2 & 3
750	47 pCi/liter	Sectors 2 & 3

2 miles from site

200'	16 pCi/liter	Sector 3
300'	20 pCi/liter	Sector 2
400'	15 pCi/liter	Sectors 2 & 3
500'	46 pCi/liter	Sector 3
750	18 pCi/liter	Sector ??
1000	20 pCi/liter	Sector 3

MODEL CALCULATIONS

Time	Source (pCi/s)	Instantaneous Calculations (s/m^3)		Estimated Concentration (pCi/liter)	
		Innermost Contour	Maximum Value	Innermost Contour	Maximum Value
0600	2.8×10^{10}	3×10^{-6}	7.5×10^{-6}	84	210
0700	5.7×10^{11}	3×10^{-6}	5.4×10^{-6}	170	310
0800	5.4×10^{10}	3×10^{-6}	7×10^{-6}	160	380

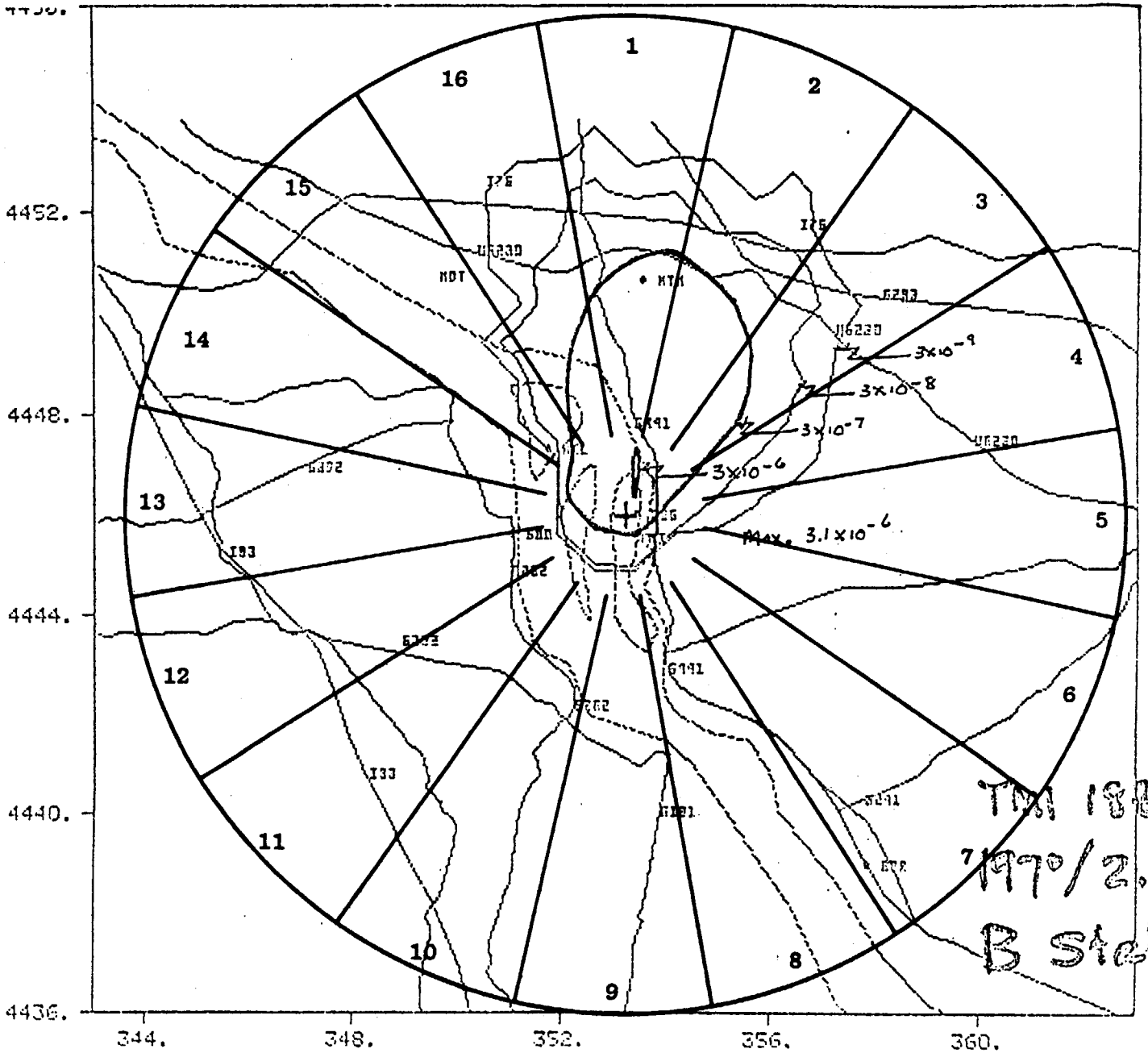

FIG. 1 Instanteous Concentration Isopleths 60 m Above Surface Calculated for Unit Rate Release and Valid for 1600 EDT, June 29, 1980.

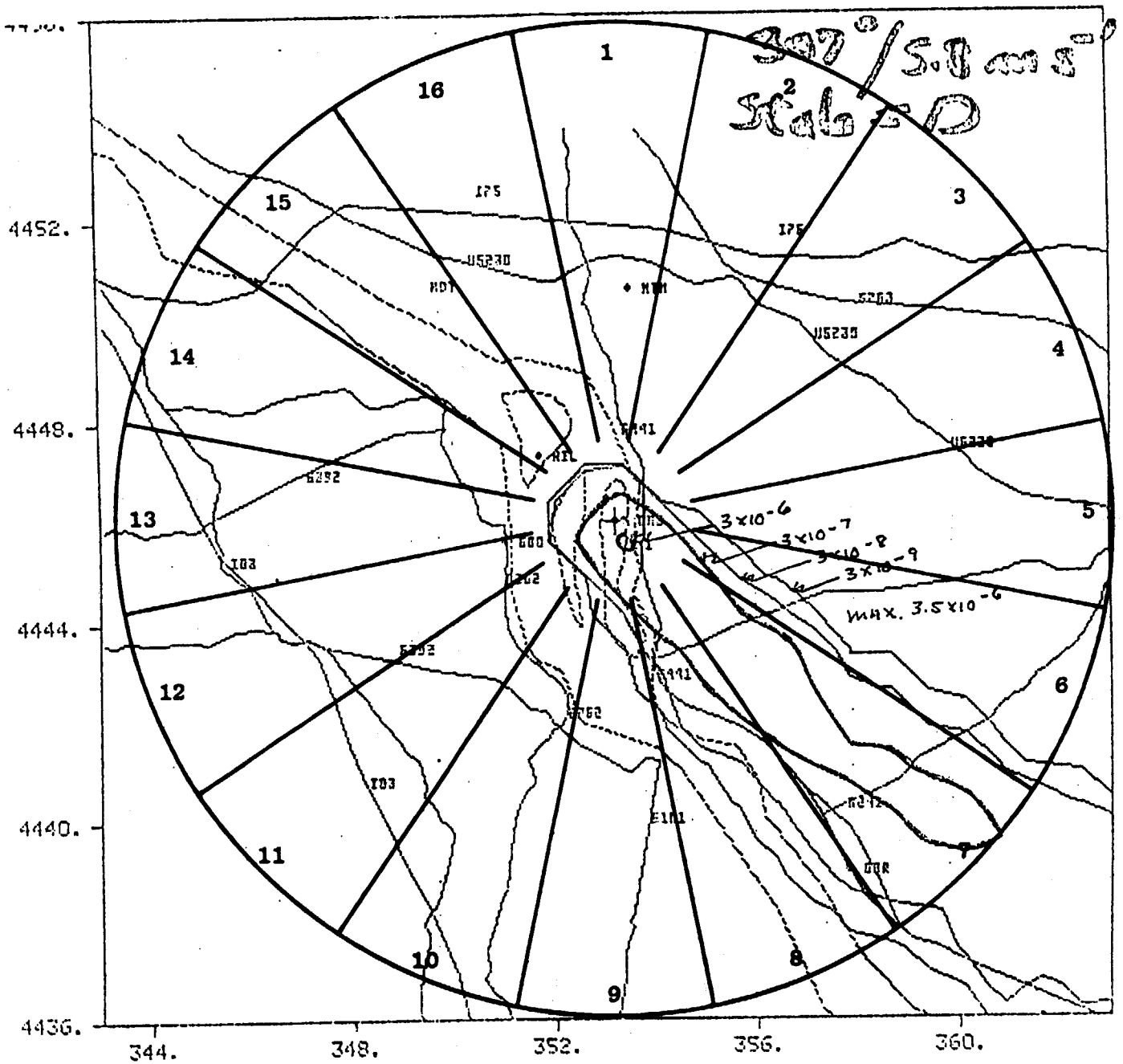

FIG. 2 Same as Fig. 1 Except Valid for 1200 EDT, June 30

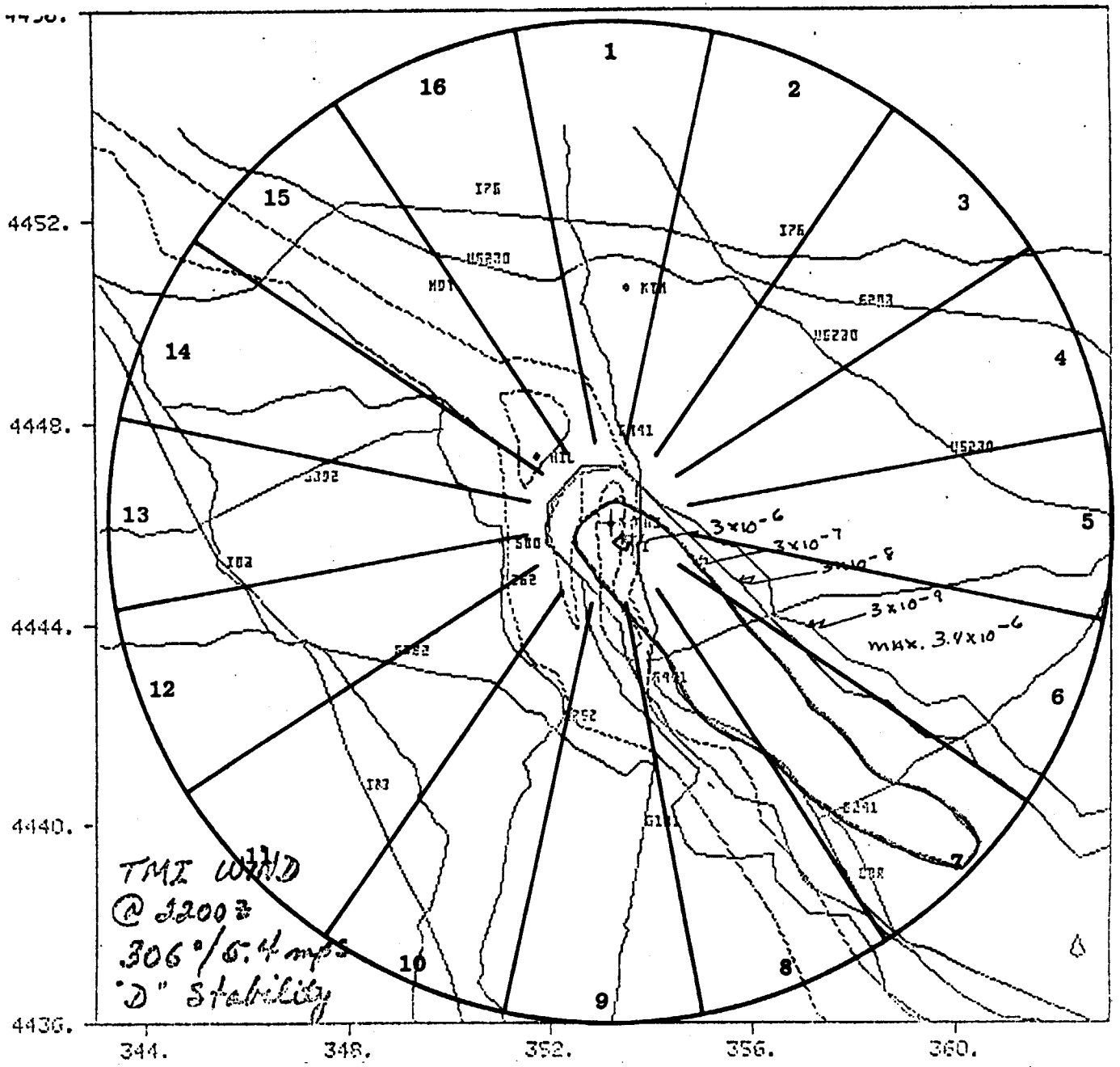

FIG. 3 Same as Fig. 1 Except Valid for 1900 EDT, June 30

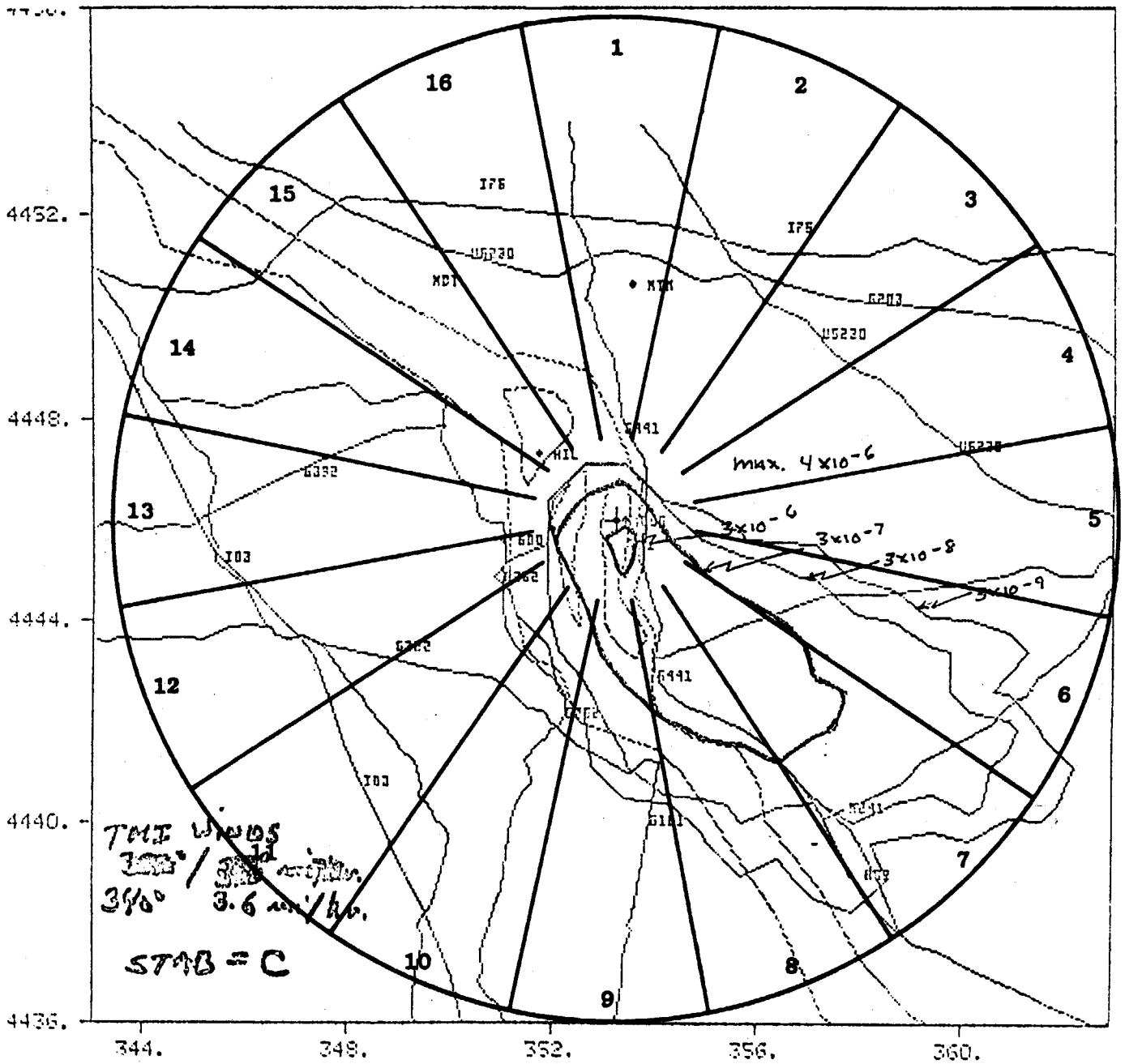

FIG. 4 Same as Fig. 1 Except Valid for 1200 EDT, July 1

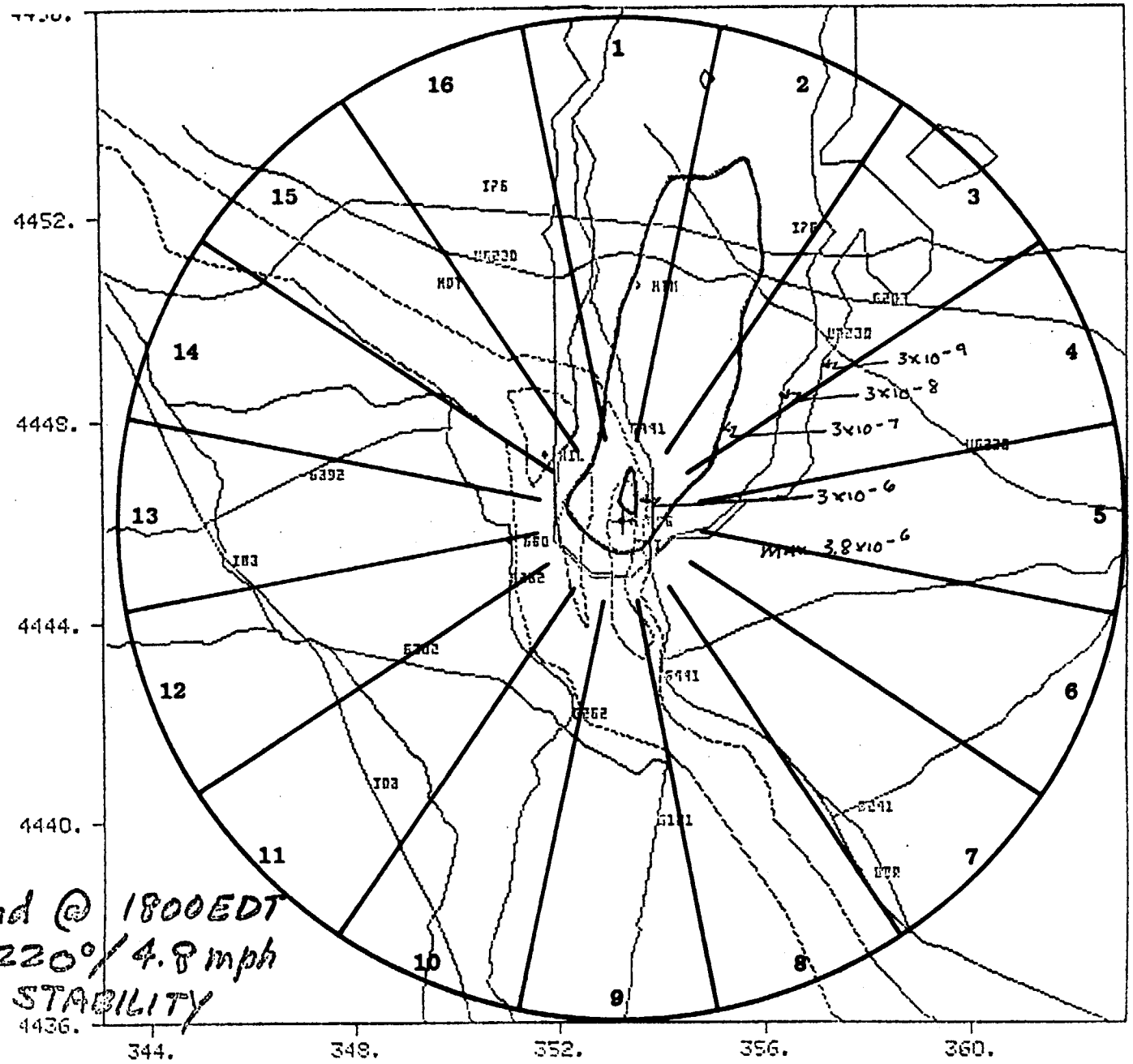

FIG. 5 Same as Fig. 1 Except Valid for 1900 EDT, July 1

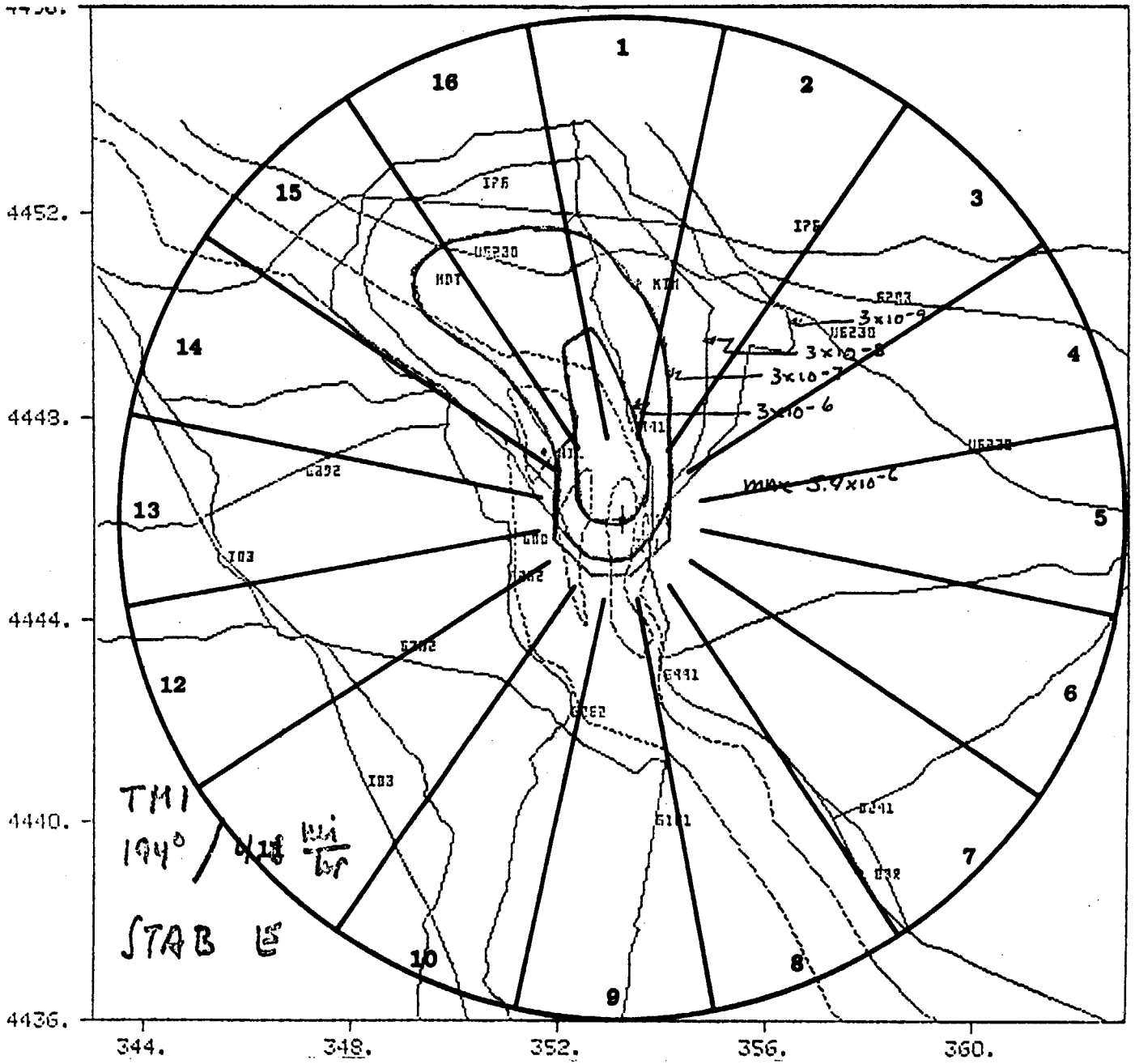

FIG. 6 Same as Fig. 1 Except Valid for 0700 EDT, July 2